IDS (1)

PATENT ABSTRACTS OF JAPAN

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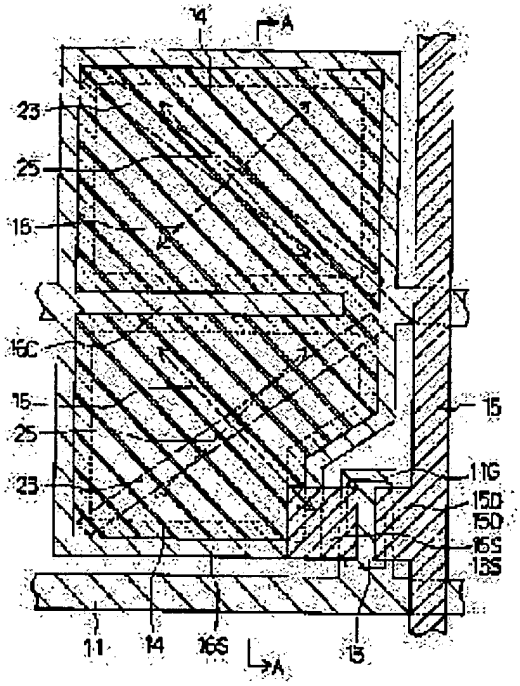
(54) LIQUID CRYSTAL DISPLAY DEVICE

(57)Abstract:
PURPOSE: To provide a liquid crystal display device having a large angle of view field by dividing a display pixel into plural regions having different orientation.
CONSTITUTION: A pixel is divided into two regions different in directons of initial parallel orientation by patterning grooves by photolithography. Furthermore, the pixel is divided into two regions showing different orientation directions when the pixel is driving by controlling the electric field of an orienting controlling electrode 16C and an orientation controlling window 23. Thereby, the display pixel is divided into four regions of different orientation. Since the priority angle of view field of each region is composed and visually recognized, the angle of view field is extended as a whole.



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* NOTICES *

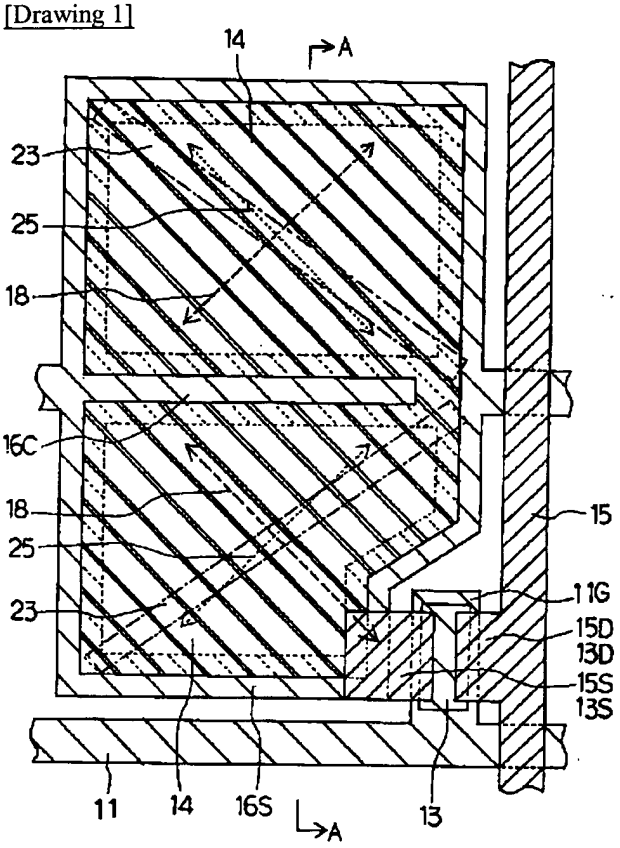
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the plan of the LCD concerning the example of this invention.
[Drawing 2] It is the cross section of A-A **** of drawing 1 .
[Drawing 3] It is a plan explaining the operation effect of this invention.
[Drawing 4] It is the plan showing the orientation of orientation of the red pixel concerning the example of this invention.
[Drawing 5] It is the plan showing the orientation of orientation of the green pixel concerning the example of this invention.
[Drawing 6] It is the plan showing the orientation of orientation of the blue pixel concerning the example of this invention.
[Drawing 7] It is the property view showing the wavelength dependency of permeability.
[Drawing 8] It is the cross section of the conventional LCD.
[Drawing 9] It is a plan explaining the trouble of the conventional LCD.
[Description of Notations]
10, 20 Substrate
11 Gate Line
12 Gate Insulator Layer
13 a-Si
14 Display Electrode
15 Drain Line
16 Orientation Control Electrode
17, 24 Orientation layer
18, 25 The orientation of a slot
21 Light Filter
22 Common Electrode
23 Orientation Control Aperture
30 Liquid Crystal Layer
31 Liquid Crystal Director
32 Electric Field

[Translation done.]

DRAWINGS

[Drawing 1]



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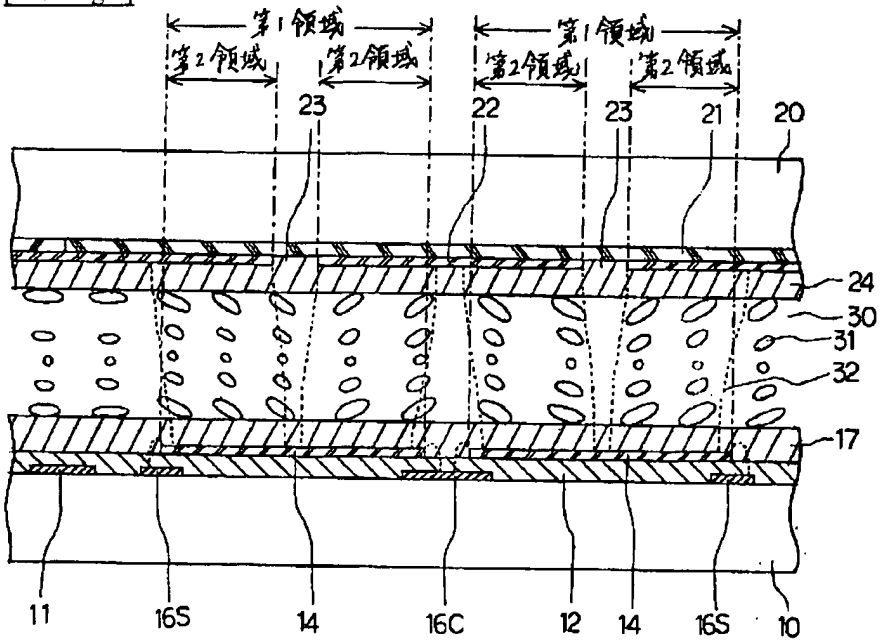
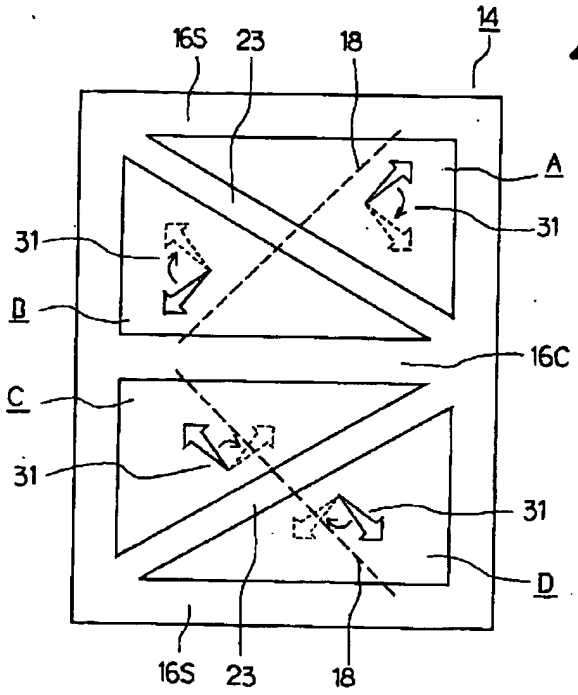
[Drawing 2]

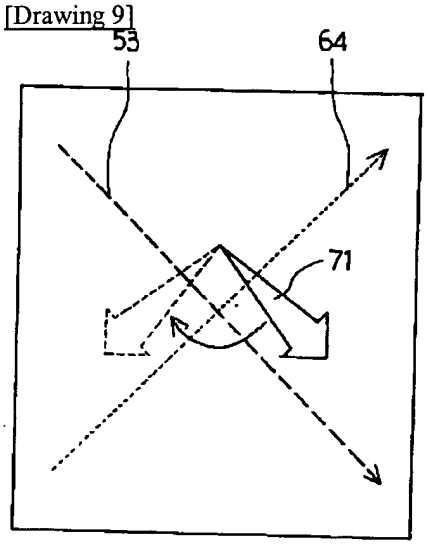


[Drawing 3]

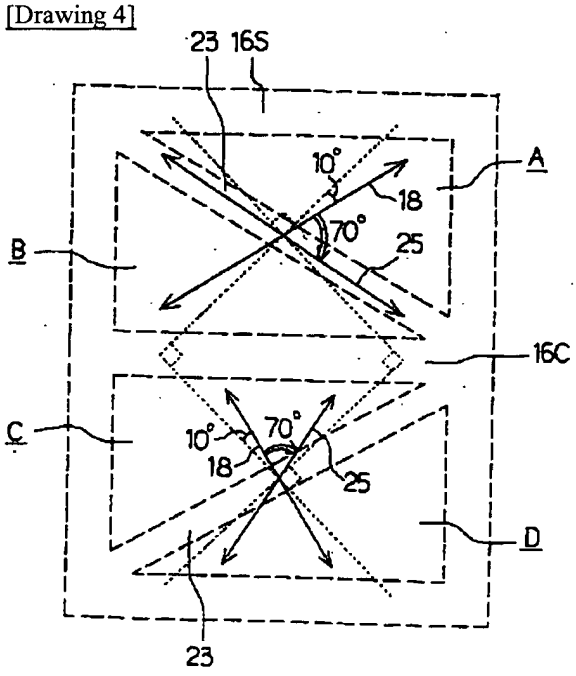


Drawing 3

[Drawing 9]



[Drawing 4]



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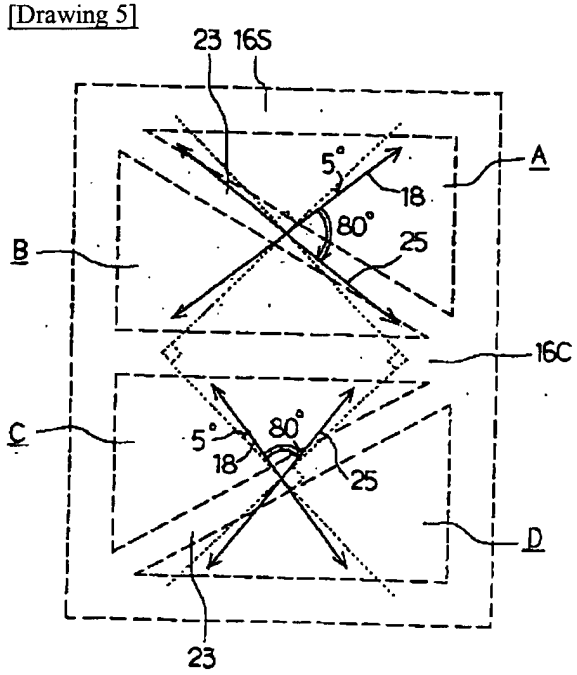
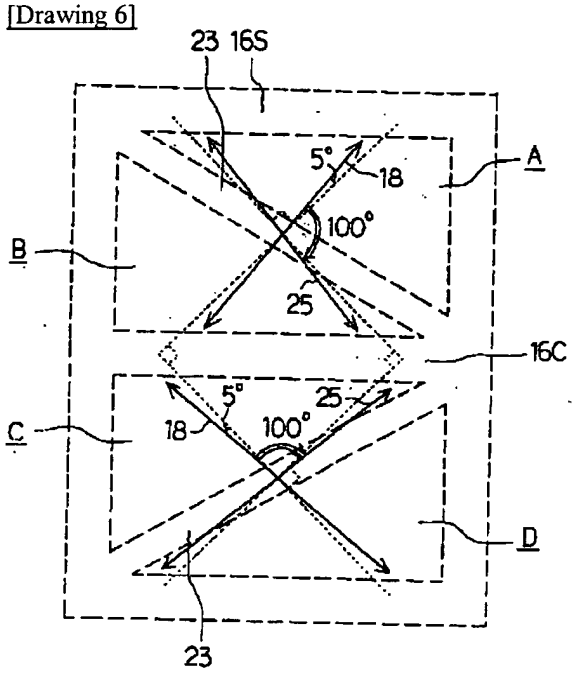
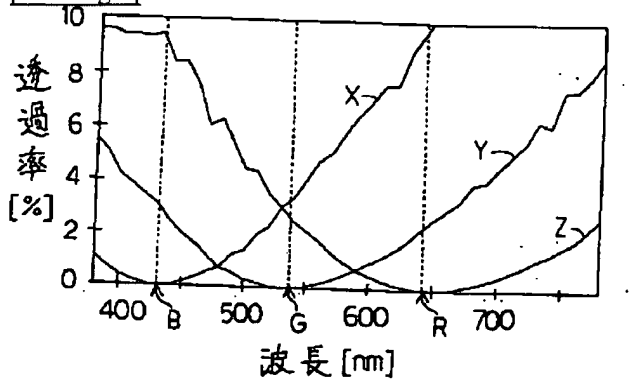


[Drawing 6]



[Drawing 7]



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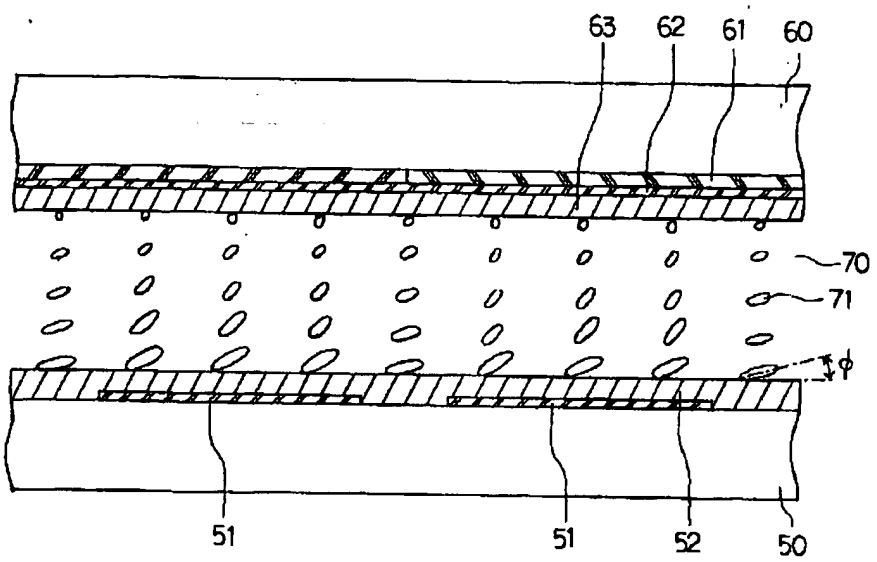

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] Especially this invention relates to the LCD which attained a wide-field-of-view angle and high display quality by controlling a liquid crystal director's orientation about a LCD.
[0002]
[Description of the Prior Art] A LCD has advantages, such as a thin shape, lightweight, and a low power, and utilization is progressing as a display unit in fields, such as OA equipment and an AV equipment. Two substrates in which the transparent electrode of a predetermined pattern was prepared are stuck on both sides of a liquid crystal layer with a thickness of micrometers [several], and a LCD is constituted by putting this further with two polarizing plates with which a polarization shaft intersects perpendicularly mutually. The drive of several 10,000 to several 100,000 pixel is possible for especially the matrix type that drives liquid crystal by choosing arbitrarily the intersection which carried out transposition arrangement of a scanning electrode group and the data electrode group, and impressing a voltage to display pixel capacity, and it fits the big screen and the high definition display display unit.
[0003] TFT (Thin Film Transistor:thin film transistor) is especially arranged for every display pixel as a switching element for selection, and the active matrix type which enabled the line sequential drive is used for the display of TV etc. In the active matrix type, the gate line for scanning signals and the drain line for data signals are formed on the same substrate, and TFT which used non-single crystal semiconductor layers, such as a-Si and p-Si, as a barrier layer is formed in the intersection of both lines. The display electrode which turns into one electrode of display pixel capacity on the same substrate is arranged in the shape of a matrix, and is connected to TFT, respectively. On another [by which opposite arrangement was carried out on both sides of the liquid crystal layer] substrate, the common electrode is formed extensively, and each opposite fraction with a display electrode serves as display pixel capacity. A display electrode and a common electrode consist of transparent electric conduction layers, such as ITO, and can face now change of the optical status of the liquid crystal of a clearance squarely. Scanning selection of the gate line is carried out line sequential, it sets all TFT on the same scanning line to ON, and supplies the data signal which synchronized with this to each display electrode through a drain line. Liquid crystal is driven also for a common electrode with the voltage difference with each display electrode which a voltage is set up synchronizing with a scanning of a gate line, and counters, and the permeability of light is controlled. Among un-choosing, the voltage impressed to display pixel capacity is held by OFF resistance of TFT, and the drive status of liquid crystal is continued. Moreover, the light filter of red (R), green (G), or blue (B) can be installed in each display pixel capacity, each display pixel can be colored, and a color picture can be obtained by the additive mixture of colors of these color dots.
[0004] Drawing 8 is a cross section having shown the cellular structure of such a LCD. On the transparent substrate (50, 60), the transparent electrode (51, 62) used as a display electrode and a common electrode is formed, respectively, and it is located in the upper and lower sides whose liquid crystal layer (70) was pinched. Moreover, the orientation layer (52, 63) which consists of poly membranes, such as a polyimide, on a transparent electrode (51, 62) is covered, and surface-orientation processing is made by rubbing. Moreover, the light-filter layer (61) of R, G, and B is installed in the substrate (60) side. Furthermore, although illustration was omitted, the polarizing plate is arranged on the outside of both substrates (50, 60).
[0005] A liquid crystal layer (70) is the nematic liquid crystal which has a positive dielectric constant anisotropy, mixed chiral material, and gave the directivity of the orientation of torsion. Although a liquid crystal director (71) does orientation in parallel with a substrate according to the surface treatment side of an orientation layer (52, 63), he will be in the initial orientation status with few initial inclination (pre tilt) angles (phi) along the orientation of rubbing. In the orientation in which rubbing intersects perpendicularly mutually about both substrates (50, 60), between vertical substrates, a line crack and liquid crystal are twisted at 90 degrees, and are arranged.
[0006] By being called TN (Twisted Nematic) method, impressing a voltage, and forming the electric field in a liquid crystal layer (70), using the electro-optics-anisotropy of liquid crystal, a such type LCD changes a liquid crystal director (71) so that it may meet in the orientation of the electric field from the early parallel orientation status, and it controls the luminosity of a pixel. Although the incidence linearly polarized light between both polarizing plates is guided in accordance with a liquid crystal director's (71)'s torsion as it is at the time of voltage-less impressing, by being twisted by voltage impression and canceling the status, other polarization components are given and the incidence linearly polarized light turns into an elliptically polarized light. The method used for narrowing down of the transmitted light is called normally white mode from such linearly polarized light depending on how to take a polarization shaft for the change to an elliptically polarized light, and the method used for increase of the transmitted light is called normally black mode.
[0007]
[Problem(s) to be Solved by the Invention] Then, the trouble of the conventional LCD is explained. Drawing 9 is drawing which projected the orientation of a liquid crystal director (71) superficially, when TN cell is seen from a top. The dashed-line arrow

head (53) is the lower orientation of rubbing, and the dotted-line arrow head (64) is the upper orientation of rubbing. Although 90 degrees rotates to a clockwise rotation and the liquid crystal director (71) is arranged toward the top from the bottom at the time of voltage-less impressing, in the contact surface with vertical both substrates, a liquid crystal director (71) stands up in the orientation which increases a pre tilt angle by impressing a voltage. A liquid crystalline director (71) turns upwards the orientation shown by the dashed-line arrow head, starts, with the up side, turns downward the orientation shown by the dotted-line arrow head, and starts with the down side.

[0008] Since the orientation status of liquid crystal over an optical path also changed with change of a viewing angle relatively by the LCD of the conventional TN method on the principle [like / like this], depending on the viewing angle, the display property also changed sharply, and the viewing-angle dependency was high. In especially the conventional example shown in drawing 9 , the viewing-angle dependency was high in the vertical orientation, and the angle of visibility was narrow. Moreover, although rubbing processing was performed by grinding an orientation layer front face against a cheesecloth etc. physically, at this time, static electricity and the foreign matter were generated and it had become the cause of a yield fall.

[0009]

[Means for Solving the Problem] Two substrates which accomplish this invention in view of the above technical probrem, counter the 1st on both sides of a liquid crystal layer, and have been arranged, It has the orientation processing side formed in the contact front face with the liquid crystal layer on the transparent electrode arranged at the opposite side side of two substrates, and two aforementioned substrates. this -- In the LCD which displays by modulating light for every unit of the display pixel constituted so that a desired voltage could be impressed to the capacity formed in the opposite fraction and the aforementioned liquid crystal layer of the aforementioned transparent electrode While the aforementioned orientation processing side makes liquid crystal arrange in parallel, without giving an initial tilt angle It is the configuration which adjusted the orientation control electrode which insulates electrically to one side of the transparent electrode by which opposite was carried out [aforementioned], and has been arranged at it, and the electric field impressed in the aforementioned liquid crystal layer by the orientation control aperture formed in another side of a transparent electrode by which opposite was carried out [aforementioned] of the absence of an electrode, and controlled the orientation of liquid crystal.

[0010] The aforementioned orientation processing side is a configuration which is the orientation layer with which the detailed slot was formed in the contact front face with the aforementioned liquid crystal layer in the 1st configuration the 2nd. It is the configuration of the slot of the aforementioned orientation layer being formed in the orientation of a plurality in the field of a display pixel in the 2nd configuration the 3rd, and dividing a display pixel into the 1st to two or more fields in which the initial orientation of liquid crystal is different.

[0011] It is the configuration divided into the 2nd to two or more fields in which the aforementioned orientation control electrode is arranged in the field of a display pixel in the 3rd configuration at the boundary line top of the 1st aforementioned split while it is arranged in the periphery of a display pixel, and the aforementioned orientation control aperture is arranged in each field of the display pixel carried out [aforementioned] the 1st ****, and the orientation of the liquid crystal at the time of voltage impression is different in the 4th. While one side of the aforementioned transparent electrode which carries out opposite is a display electrode respectively arranged independently in the shape of a matrix corresponding to a display pixel in the 4th configuration and the aforementioned orientation control electrode is arranged along the periphery of the aforementioned display electrode the 5th It is arranged along with the absent fraction of the electrode formed into the aforementioned display electrode, and another side of the aforementioned transparent electrode which carries out opposite is a common electrode which counters common to each aforementioned display electrode, and the aforementioned orientation control aperture is a configuration currently formed into the aforementioned common electrode.

[0012] While a signal is supplied to the 6th in the 5th configuration by the TFT to which each aforementioned display electrode was connected electrically, respectively, each aforementioned display electrode is a configuration which is the configuration from which the angle of the bending fraction of the bridle wire with the field where an electrode becomes absent in the existence region of the aforementioned TFT becomes more than a right angle. In either of the 6th configuration from the 2nd configuration, the VCF layer which absorbs light other than predetermined wavelength is prepared, and the aforementioned display pixel displays each color of red, green, or blue on the 7th, and the orientation of the slot of the aforementioned orientation layer is a configuration which crosses at an angle different for every display pixel which displays each aforementioned color about both the front faces of the liquid crystal layer which counters.

[0013] The angle which crosses by both the contact surfaces of the liquid crystal layer to which the orientation of the slot of the aforementioned orientation layer counters the octavus in the 7th configuration is a configuration set up so that angle of torsion of the liquid crystal determined that the permeability of the display pixel which displays each color at the time of voltage-less impressing will serve as the minimum from the rate of a birefringence of a liquid crystal layer thickness and liquid crystal and the wavelength of the light of each color may be realized.

[0014]

[Function] With the 1st aforementioned configuration, in the initial orientation of liquid crystal, while setting up in parallel, at the time of voltage impression, liquid crystal is started in the orientation without a pre tilt angle specified by the orientation control electrode and the orientation control aperture. That is, since the electric field in a liquid crystal layer incline in the orientation of slant and become a non-right angle to the orientation of initial orientation of liquid crystal near the orientation control electrode, the liquid crystal director who has a positive dielectric constant anisotropy changes so that it may approach in the orientation of the electric field by the shortest, and becomes stable in energy.

[0015] On the other hand, since an orientation control aperture is an electrode absence, since the electric field are below thresholds weakly, a liquid crystal director is fixed to the early parallel orientation status in this near. Moreover, since the electric field generated from the electrode which counters an orientation control aperture avoid an orientation control aperture and go to an electrode presence fraction, since the electric field incline aslant, a liquid crystal director approaches in the orientation of the electric field by the shortest, and becomes [around an orientation control aperture] stable in energy also here.

[0016] Thus, since the orientation of liquid crystal is controlled by the orientation control electrode and the orientation control aperture, while the orientation of orientation of liquid crystal can be specified in each field specified in this way by forming these electrodes and an aperture in a predetermined configuration, orientation is uniformly arranged in each field for the continuum nature of liquid crystal. With the 2nd aforementioned configuration, while the parallel orientation which does not have a pre tilt angle by forming a detailed slot in the front face of an orientation layer using photo lithography etc. becomes possible, rubbing processing becomes unnecessary and occurrence of static electricity and a foreign matter is prevented.

[0017] It is divided into two or more fields in which the orientation of initial orientation of liquid crystal is different by dividing the field of a display pixel into two or more fields in which the orientation of a slot is different with the 3rd aforementioned configuration. While an orientation control electrode is arranged on the boundary line of the field in which the orientation of a slot is different in the field of a display pixel with the 4th aforementioned configuration, it is further divided into two or more fields in which the orientation of liquid crystal is different at the time of voltage impression by arranging an orientation control aperture in the same field of the orientation of a slot. Thus, since each field has the different priority viewing-angle orientation by dividing one display pixel into two or more fields in which the orientation of liquid crystal is different by the orientation control electrode and the orientation control aperture, a viewing-angle dependency is reduced collectively and wide-field-of-view cornification can be realized.

[0018] In the display electrode in which the electrode absent fraction was formed with the 5th aforementioned configuration corresponding to the boundary of a pixel split, while an orientation control electrode is arranged into the periphery and an electrode absent fraction each pixel field divided into the common electrode by which opposite arrangement was carried out -- further -- by carrying out opening of the orientation control aperture divided into two, the electric-field distribution in a cell is adjusted the the best for a control of a liquid crystal director's orientation, and a desired pixel split is made

[0019] While the configuration of a display electrode is formed in the field which became the electrode absence by presence of TFT so that a corner may become blunt, by arranging an orientation control electrode along with the bridle wire of a display electrode, it prevents the electric field being crowded with corners, and a liquid crystal director's orientation is stably controlled by the 6th aforementioned configuration. Although the angles which rotatory power, i.e., the linearly polarized light, rotates with wavelength with the 7th aforementioned configuration according to torsion of liquid crystal differ By [which displays the angle which the orientation of the slot of an orientation layer intersects among both substrates about each display pixel by which only the light of predetermined wavelength is penetrated by the VCF layer] making it differ for every color and changing angle of torsion of liquid crystal according to the difference in the rotatory power of each wavelength When displaying black by shading, the tinction by the leakage light of optical rotatory dispersion can be lost completely.

[0020] Since angle of torsion and wavelength of permeability, a liquid crystal layer thickness and the rate of a birefringence of liquid crystal, and liquid crystal are in the relation of a one for one with the configuration of the aforementioned octavus, angle of torsion of the liquid crystal when making permeability into the minimum is determined by the wavelength of light. For this reason, it can leak, when each color pixel displays black by forming the slot of an orientation layer at the time of voltage-less impressing so that angle of torsion which makes permeability the minimum about each color display pixel may be realized, and the tinction by light can be prevented.

[0021]

[Example] Hereafter, this invention is explained in detail based on an example. First, the 1st example is explained, referring to a drawing. Drawing 1 is a plan of a 1 display pixel. A gate line (11) and a drain line (15) intersect TFT substrate side, it is arranged, and the display electrode (14) is arranged in the field surrounded by both lines (11, 15). Moreover, the laminating of the source drain electrode (15S, 15D) is carried out to the intersection of both lines (11, 15) one by one through a gate electrode (11G), a gate insulating layer (12), a-Si (13), and a low resistance a-Si layer (13S, 13D), TFT is formed, and the source electrode (15S) is connected to the display electrode (14). The fraction (16S) which the orientation control electrode (16) which insulates from a display electrode (14) and has been arranged encloses the periphery of a display electrode (14), and has been arranged, and the fraction (16C) arranged by crossing the center of a display electrode (14) are formed in one. Into a display electrode (14), a center is crossed, an electrode forms an absent strip region, the orientation control electrode (16C) corresponding to this is exposed, and it is considering as the configuration which performs an orientation control also in this fraction. Namely, while orientation is controlled by the orientation control electrode (16S) of the periphery section from the periphery in the field of a display pixel, as for liquid crystal, the orientation of each field divided by the orientation control electrode (16C) of the center which carries out a display pixel for 2 minutes is controlled. In addition, each fraction of the display electrode (14) divided by the electrode absent band has acquired sufficient orientation control effect of the whole display pixel in this example, without increasing wiring resistance of a display electrode (14) by connecting by about 10 micrometer width of face in the edge near the source electrode (15S) of an electrode absent band, although it connects by one place or two or more places.

[0022] On the other hand, a common electrode is extensively formed in the opposite substrate side countered and arranged on both sides of liquid crystal, and opening of the orientation control aperture (23) which is an electrode absent fraction is carried out to band-like into the common electrode. The orientation control aperture (23) is formed along with the diagonal line which turned to the mutually different orientation of each display pixel carried out by the central orientation control electrode (16C) for 2 minutes. Drawing of longitudinal section of A-A **** of drawing 1 is shown in drawing 2 , and the cellular structure is explained. On transparent substrates (10), such as glass, a gate line (11) and an orientation control electrode (16S, 16C) are formed of Cr etc., this is covered, and the laminating of the gate insulating layers (12), such as SiNX, is carried out. Gate lines (11) are a gate electrode (11G) and one, and the gate insulating layer (12) is as common as TFT section. The display electrode (14) of ITO is formed on a gate insulating layer (12), and it connects with the source electrode (15S) of TFT which was not illustrated. The pars marginalis of a display electrode (14) is partially overlapped on the orientation control electrode (16S), an orientation control electrode (16C) is prepared corresponding to the electrode absent section formed in band-like so that an orientation control can be performed, and it controls the electric field (32) in a liquid crystal layer (30). In addition, in order that an orientation control may carry out effectively from the edge line to which a display electrode (14) corresponds, the orientation

control electrode (16S, 16C) is taken as the design superimposed partially so that a display electrode (14) may be made to approach.

[0023] Orientation layers (17), such as a polyimide and SiO2, are formed by the contact surface with a liquid crystal layer (30), the detailed slot of 2 - 3 micrometer pitch is formed of photo lithography, and the initial orientation of liquid crystal is controlled to a substrate in parallel. The slot is formed in the orientation shown by the dashed-line arrow head (18) of drawing 1 , and an orientation control electrode (16C) covers the boundary of the field from which the orientation (18) of a slot is different within a display pixel, and is formed. Thus, a display pixel is divided into the 1st two field surrounded by the orientation control electrode (16C) and the orientation control electrode (16S), and the orientation layer (17) of the 1st field is formed, respectively, so that about 90 degrees (18) of the orientation of a slot may differ mutually.

[0024] On another [by which opposite arrangement was carried out on both sides of the liquid crystal layer (30)] substrate (20), the light-filter layer (21) of R, G, and B is formed for every pixel, and the common electrode (22) of ITO is extensively formed on this. Into the common electrode (22), opening of the electrode absent fraction is carried out by etching elimination etc., and it has become the orientation control aperture (23). An orientation control aperture (23) is formed along with the diagonal line of each 1st field, and divides each 1st field into the 2nd two field in which orientation is different at the time of voltage impression. In drawing 1 , the orientation layer (24) with which the detailed slot was formed is prepared in the orientation shown by the dotted-line arrow head (25) like the substrate (10) side at the contact surface with a liquid crystal layer (30). As shown in drawing 1 , while the 90 degrees (25) of the orientation of a slot of an orientation layer (24) differ mutually about the 1st field of the display pixel bordering on the line corresponding to an orientation control electrode (16C), in the 1st field, the orientation (18) of a slot by the side of a substrate (10) differs from the 90 degrees (25) of the orientation of a slot by the side of a substrate (20), respectively.

[0025] The orientation of the liquid crystal at the time of voltage impression is controlled by this invention for the electric field (32) which inclined aslant from the normal of a substrate by operation of the orientation control electrode (16S, 16C) arranged in the predetermined location and an orientation control aperture (23) so that it is shown in drawing 2 , while a liquid crystal director's (31)'s initial orientation is specified to a substrate in parallel without giving a pre tilt angle. That is, orientation is carried out so that it may start so that a liquid crystal director (31) may be suitable in the orientation of the electric field with the first stage parallel orientation status to the shortest in the fraction to which the electric field (32) were aslant leaned by the orientation control-electrode (16S, 16C) and orientation control aperture (23) although the liquid crystal director (31) which has a positive dielectric constant anisotropy was suitable in the orientation of the electric field, and this may be followed also in the fraction of others further for For this reason, within a display pixel, while the orientation of orientation of liquid crystal is specified, it is uniformly arranged in a zone in each zone specified by the orientation control electrode (16S, 16C) and the orientation control aperture (23).

[0026] Moreover, since it is further divided into a 2-way by operation of an orientation control-electrode (16S, 16C) and orientation control aperture (23) as by setting the orientation of initial orientation as a 2-way within an one display pixel beforehand by patterning of the orientation layer (17, 24) by photo lithography explained in the top at the time of a drive, orientation can be made to carry out in the four orientation after all.

[0027] In addition, in this example, as shown in drawing 1 , while a display electrode (14) is formed in a configuration to which an edge line meets in the extended orientation of an orientation control aperture (25) [near the TFT], the orientation control electrode (16S) is formed so that the edge line may be met. If it becomes the configuration where it entered inside from the extension wire which the edge line of a display electrode (14) met each side in the formation fraction of TFT, the slanting electric field specified along with an edge line (16S), i.e., an orientation control electrode, will be crowded with these fractions, and a liquid crystal director's orientation will also be confused. If there are abnormalities of orientation also partially, such an orientation unusual field will spread for the continuum nature of liquid crystal, and display quality will be affected. Therefore, by forming a display electrode (14) in a configuration which is shown in drawing 1 , and blunting bending of an edge line, confusion of the electric field can be suppressed and turbulence of a liquid crystal director's orientation can be prevented.

[0028] An operation of the liquid crystal by these operations is explained, referring to drawing 3 . the display pixel divides a periphery into the 2 1st field (A, B) (C, D) by the orientation control electrode (16C) while it is enclosed by the orientation control electrode (16S) -- having -- further -- every -- the 1st field (A, B) (C, D) is divided into the two each 2nd field (A), (B), (C), and (D) by the orientation control aperture (23) That is, a display pixel is divided into four zones (A, B, C, D) by an orientation control electrode (16C) and the orientation control aperture (23). While the slot (18, 25) is formed in the same orientation in the zone (A), the zone (B), and a zone (C) and a zone (D), respectively, in the zone (A, B) and the zone (C, D), the 90 degrees of the orientation of a slot differ mutually. For this reason, in an initial state, in a zone (A), a zone (B), and a zone (C) and a zone (D), a liquid crystal director (31) is in the status differ in a zone (A, B) and a zone (C, D) while he is in the respectively same torsion status. And as for a liquid crystal director (31), opposite orientation is started from the respectively same initial orientation status by impressing a voltage and driving liquid crystal in a zone (A), a zone (B), and a zone (C) and a zone (D). That is, it is divided into four different torsion orientation status within one display pixel including a liquid crystal director's (31)'s inclination orientation.

[0029] Thus, since the priority viewing-angle orientation in which each field is different by dividing a display pixel into four fields in which orientation is different is compounded, a viewing-angle dependency is reduced. That is, in the LCD of the conventional TN method, although it has only the one priority viewing-angle orientation, the four priority viewing-angle orientation can be given by dividing into four pixels from which torsion is different.

[0030] Next, the 2nd example of this invention is explained. this example is a LCD which consists of a display pixel which has the electrode disposition of the 1st example, and is the configuration that it was suitable for RGB color display, further. Drawing 4 to the drawing 6 is a plan having shown the orientation (18, 25) of a slot of an orientation layer (17, 24) about the display pixel which displays red (R), green (G), or blue (B), respectively. In addition, deltand value of a liquid crystal layer (30) is 0.45 micrometers (for rate [of a birefringence] deltan of liquid crystal, 0.09 and cell gap d are 5 micrometers).

[0031] The relation of the wavelength dispersion of the permeability at the time of voltage-less impressing at the time of changing angle of torsion of liquid crystal into drawing 7 in the normally black mode first is shown. When angle of torsion of (X) is 100 degrees, as for 80 degrees and (Z), angle of torsion of (Y) is the case where angle of torsion is 70 degrees. (X), (Y), and (Z) become perfect [the shading status] near the wavelength which shows blue (B), green (G), and red (R), respectively so that clearly from drawing.

[0032] Although the point that it can drive by the low battery compared with a normally white mode, and the viewing-angle dependency of contrast were generally excellent in the point of the parvus in order that the normally black mode might obtain a black display by voltage-less impressing, when obtaining a black display, it had the problem that level low enough could not be obtained, for the wavelength dispersion of the permeability shown also in drawing 7 . For example, in TN method with a usual angle of torsion of 90 degrees, although black level low enough could be obtained by voltage-less impressing in the green pixel, about red and the blue pixel, it colored for the leakage light by optical rotatory dispersion, and contrast and the hue were affected.

[0033] For this reason, in this invention, by setting up the angle which the orientation (18) of a slot of an orientation layer and (25) intersect for every color pixel, optical leakage is prevented, black level low enough is obtained, and the display property is improved. That is, according to rotatory power different for every wavelength, about R pixels, contrast improves by setting G pixels as 80 degrees, and setting B pixels of angle of torsion as 70 degrees at 100 degrees, respectively, and the good color is obtained.

[0034] For the general relation between such a foreground color and angle of torsion of liquid crystal, the relation between permeability T of the light at the time of voltage-less impressing, cell gap d and rate [of a birefringence] deltan of liquid crystal, wavelength lambda, and angle-of-torsion theta is Gooch. and It is expressed by the formula of Tarry.

[0035]

[Equation 1]

$$T = \sin^2 [\theta (1 + u^2)^{1/2}] / (1 + u^2)$$

[0036] It is here and is [0037].

[Equation 2]

$$u = \pi d \Delta n / \theta \lambda$$

[0038] It comes out. In R pixels shown in drawing 4 from this formula, the angle of the orientation (18) of a slot by the side of TFT substrate and the orientation (25) of a slot by the side of an opposite substrate to accomplish is made into 70 degrees, and chiral material is mixed, the directivity of the orientation of torsion is given, and toward an opposite substrate side, a liquid crystal director rotates to a clockwise rotation, and is arranged in [angle] 70 degrees from TFT substrate side by the initial state. Each orientation (18) of a slot differs from (25) bordering on the orientation control electrode (16C), the viewing-angle property of a zone (A, B) improves to a longitudinal direction, and the viewing-angle property of a zone (C, D) improves in the vertical orientation. [90-degree]

[0039] Similarly, in drawing 5 , the angle which the orientation (18) of a slot and (25) constitute among both substrates is made into 80 degrees. Moreover, in drawing 6 , the angle which the orientation (18) of a slot and (25) accomplish among both substrates is made into 100 degrees, and toward an opposite substrate side, the liquid crystal director by whom the orientation of torsion was specified rotates to a clockwise rotation, and is arranged in [angle] 100 degrees from TFT substrate side.

[0040] the structure which carried out wide-field-of-view cornification by dividing a pixel as the ** 1st example explained in Table 1, and the structure which set up angle of torsion for ** each color pixel of every, and improved the display property -- and ** As the +** 2nd example explained, while the pixel split was carried out, the experimental result which investigated the angle of visibility from which a contrast ratio becomes five or more, and the angle of visibility without a tone reversal in the orientation of four directions about the structure which set up angle of torsion for every color pixel, respectively was shown. Moreover, the same experimental result about the conventional 90 degree torsion orientation TN method was mentioned as an example of a comparison.

[0041]

[Table 1]

	コントラスト比5以上の視野角（度）				階調反転のない視野角（度）			
	上	下	左	右	上	下	左	右
TN	20	50	55	55	15	15	50	50
①	35	35	40	40	50	50	50	50
②	45	45	55	55	40	40	40	40
①+②	50	50	50	50	50	50	50	50

[0042] As shown in a table, although the angle of visibility has spread by one of a contrast ratio and the tone reversals, by **+**, the viewing-angle property is improving equally about both at ** or **. In Table 1, the five or more-contrast ratio angle of visibility was compared with the angle of visibility without a tone reversal about four directions, and the value of each parvus way was collected into Table 2.

[0043]

[Table 2]

	コントラスト比5以上で階調反転のない視野角（度）			
	上	下	左	右
TN	15	15	50	50
①	35	35	40	40
②	40	40	40	40
①+②	50	50	50	50

[0044] Since it narrows remarkably even if an angle of visibility has a problem in any of a contrast ratio and a tone reversal, or one side, in order to reduce a viewing-angle dependency, it is necessary to improve it equally from both sides. Therefore, while patterning, the orientation control electrode, and orientation control aperture of a detailed slot divide a pixel and a tone reversal is prevented, a good viewing-angle property is acquired by setting up ******** of liquid crystal the optimum for every color pixel, and improving contrast.

[0045]

[Effect of the Invention] By performing surface-orientation processing by patterning of the slot by photo lithography, the display pixel could be divided into two or more fields in which initial orientation is different, and the operation of the orientation control electrode arranged at the position at the time of a drive of liquid crystal and an orientation control aperture was able to divide into two or more fields in which initial parallel orientation to the same orientation without a pre tilt angle is different further so that clearly from the above explanation. The display of a wide-field-of-view angle from which the priority viewing angle of each field is compounded, it crosses vertically and horizontally by this, and a display property does not change with viewing-angle orientation was obtained.

[0046] Furthermore, since the shading status at the time of a black display is improved and a display property improves simultaneously by setting up angle of torsion in early stages of liquid crystal the optimum by the color of a display pixel by patterning of a slot, a viewing-angle dependency falls remarkably. Moreover, since the rubbing process of an orientation layer was cut down, static electricity and the foreign matter by rubbing were lost, and the yield improved.

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] two substrates countered and arranged on both sides of a liquid crystal layer -- this -- the transparent electrode which is arranged at the opposite side side of two substrates, and counters mutually -- And it has the orientation processing side formed in the contact front face with a liquid crystal layer on two aforementioned substrates. In the LCD which displays by modulating light for every unit of the display pixel constituted so that a desired voltage could be impressed to the capacity formed in the opposite fraction and the aforementioned liquid crystal layer of the aforementioned transparent electrode While the aforementioned orientation processing side makes liquid crystal arrange in parallel, without giving an initial tilt angle The LCD characterized by having adjusted the electric field impressed in the aforementioned liquid crystal layer, and controlling the orientation of liquid crystal by the orientation control aperture formed in another side of the orientation control electrode which insulates electrically to one side of the aforementioned transparent electrode which carries out opposite, and has been arranged at it, and the aforementioned transparent electrode which carries out opposite of the absence of an electrode.
[Claim 2] The aforementioned orientation processing side is a LCD according to claim 1 characterized by being the orientation layer with which the detailed slot was formed in the contact front face with the aforementioned liquid crystal layer.
[Claim 3] The slot of the aforementioned orientation layer is a LCD according to claim 2 characterized by being formed in the orientation of a plurality in the field of a display pixel, and dividing a display pixel into the 1st field in which the initial orientation of liquid crystal is mutually different.
[Claim 4] the aforementioned orientation control electrode is arranged on the boundary line of the 1st aforementioned field in the field of a display pixel while it is arranged in the periphery of a display pixel -- having -- and the aforementioned orientation control aperture -- aforementioned every -- it arranges in the 1st field -- having -- aforementioned every -- the LCD according to claim 3 characterized by dividing the 1st field into the 2nd field in which the orientation of the liquid crystal at the time of voltage impression is different
[Claim 5] While one side of the aforementioned transparent electrode which carries out opposite is a display electrode respectively arranged independently in the shape of a matrix corresponding to a display pixel and the aforementioned orientation control electrode is arranged along the periphery of the aforementioned display electrode It is the LCD according to claim 4 characterized by for another side of the transparent electrode which it is arranged along with the absent fraction of the electrode formed into the aforementioned display electrode, and carries out the aforementioned opposite being a common electrode which counters common to each aforementioned display electrode, and forming the aforementioned orientation control aperture into the aforementioned common electrode.
[Claim 6] Each aforementioned display electrode is a LCD according to claim 5 characterized by being the configuration from which the angle of the bending fraction of the bridle wire of the existence region of a transparent electrode becomes more than a right angle in the existence region of the aforementioned TFT while a signal is supplied by the TFT to which each aforementioned display electrode was connected electrically, respectively.
[Claim 7] It is a LCD given in either of a claim 2 to the claims 6 characterized by preparing the VCF layer which absorbs light other than predetermined wavelength, and for the aforementioned display pixel displaying each color of red, green, or blue, and the orientation of the slot of the aforementioned orientation layer crossing at an angle different for every display pixel which displays each aforementioned color about both the front faces of the liquid crystal layer which counters.
[Claim 8] The angle which crosses by both the contact surfaces of the liquid crystal layer which the orientation of the slot of the aforementioned orientation layer counters is a LCD according to claim 7 characterized by being set up so that angle of torsion of the liquid crystal determined that the permeability of the display pixel which displays each color at the time of voltage-less impressing will serve as the minimum from the rate of a birefringence of a liquid crystal layer thickness and liquid crystal and the wavelength of the light of each color may be realized.

[Translation done.]